be properly weighed by the members generally, or the fitness of candidates in any way tested? And when it is argued that the clerk and housekeeper, as well as the Librarian, ought to be appointed by the Society also, and not by the Council, the acme of absurdity in the matter seems to have been reached.

It is quite evident, from what has been said, that the less a learned Society indulges in legislation the better. What must be called the "opposition" were anxious, at the meeting on Thursday last, for a further revision of the whole laws of the Society; fortunately, however, the common sense of the Fellows was against them. Sir John Lubbock pointed out, at the conclusion of the debate, that none of the speakers had made out even a *primâ facie* case for further change. It may be hoped, therefore, that when the technical question of the legality of the amendments has been disposed of, the Society will enjoy undisturbed peace and quietness.

One practical suggestion seems to educe itself from what has been said. The only way to settle matters of dispute of this kind is to have an authoritative arbitrator. If we ever get a minister to take charge of our scientific institutions, a legal assessor might be conveniently attached to his staff to act in lieu of a Visitor to the learned Societies which now possess a quasi-official status from being housed at the public expense. If the points which the dissentients raised in the present case could have been authoritatively and impartially settled off-hand, there would have been no need for an important scientific Society to have wasted a considerable portion of its session over matters in themselves of the slenderest possible consequence, and absolutely without importance in a scientific sense.

THE MOON

The Moon Considered as a Planet, a World, and a Satellite. By James Nasmyth, C.E., and James Carpenter, F.R.A.S. With 24 illustrative plates of lunar objects, phenomena, and scenery, and numerous woodcuts. (London: Murray, 1874.)

THE illustrations to this book are so admirable, so far beyond those one generally gets of any celestial phenomenon, that one is tempted to refer to them first of all. No more truthful or striking representations of natural objects than those here presented have ever been laid before his readers by any student of Science; and I may add that, rarely if ever, have equal pains been taken to insure such truthfulness. Mr. Nasmyth, not content with the drawings he has been accumulating for many years, has first translated them into *models*, which, when placed with a strong light shining obliquely upon them, should reproduce the ever-changing lunar effects of light and shadow. Having obtained models which bore this test, he has photographed them with the light falling, now on one side, and now on the other, to represent the sunrise and sunset appearances on our satellite, as observed in the telescope. The result is perfect; far more perfect than any enlargement of photographs could possibly have been, because, by every such enlargement, a softness is brought about, whereas, the more powerful the telescope employed and the more perfect the atmospheric conditions, the more does the unevenness and sharpness of every lunar detail come out.

But, though I have given the first place to a general reference to the illustrations, I by no means intend thereby to imply that the text is of secondary importance. In fact, the more carefully the text is read, the more obvious does it become that Mr. Nasmyth has used his drawings as a means to an end, and that he and Mr. Carpenter between them have produced a work which is not only a very beautiful and a very readable one, but one of some importance. From this point of view it is to be regretted that the book had not been published a month or two later, as then the authors might further have illustrated their subject by a reference to Mr. Mallet's most important paper on volcanic energy, which has just appeared in the "Philosophical Transactions"—a paper which supports the authors' views in many important particulars, and though it clashes with others, if we are not mistaken, a discussion of the question from the two points of view presented will ultimately enable us to carry our conclusions further than they have gone hitherto.

Again, it is not a little curious that another communication presented to the Royal Society not long ago, and not yet published in this country, may also throw new light upon one at least of the interesting points presented to the student of lunar physics. I refer to the working hypothesis on which I have attempted to explain the absence of metalloids from the sun's reversing layer in its bearing upon the moon's atmosphere.

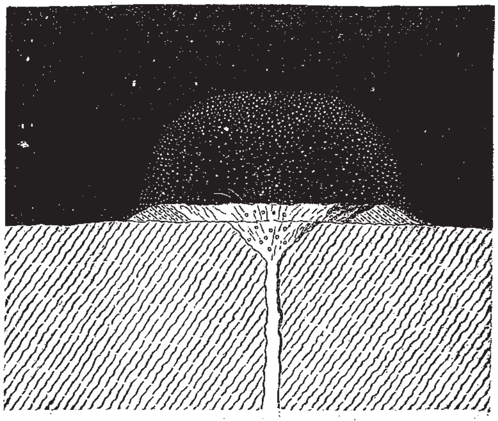

FIG. 1.—First stage of a lunar Volcano

Before, however, more detailed reference to these points, it is as well to state briefly, for those less conversant with lunar matters, the principal points in which Selenology differs from Geology, or rather the principal effects which have been produced on the moon in past time which differ from the effects which have been produced on our planet in past time.

First among these is undoubtedly the evidence of volcanic action on a scale far surpassing anything that we have an idea of here. Witness craters 74 miles in diameter, and if the walled plains are accepted as craters, then diameters of craters reaching 300 miles, the volcanic energy not being scattered here and there, but making up the entire surface over large areas.

Next, after the tremendous evidence of vulcanicity afforded by the craters and walled plains, come the bright streaks which have ever been a puzzle to observers. These are seen under various illuminations to radiate from several craters for hundreds of miles. Here I will quote from the book, p. 133:—

"There are several prominent examples of these bright streak systems upon the visible hemisphere of the moon; the focal craters of the most conspicuous are Tycho, Copernicus, Kepler, Aristarchus, Menelaus, and Proclus. Generally, these focal craters have ramparts and interiors distinguished by the same peculiar bright or highly reflective material which shows itself with such remarkable brilliance, especially at full moon; under other conditions of illumination they are not so strikingly visible. At or nearly full moon, the streaks are seen to traverse over plains, mountains, craters, and all asperities; holding their way totally disregardful of every object that happens to lie in their course. The most remarkable bright streak system is that diverging from the great crater Tycho. The streaks that can be easily individualised in this group number more than one hundred, while the courses of some of them may be traced through upwards of six hundred miles from their centre of divergence. Those around Copernicus, although less remarkable in regard to their extent than those diverging from Tycho, are nevertheless in many respects well deserving of careful examination; they are so numerous as utterly to defy attempts to count them, while their intricate reticulation renders any endeavour to delineate their arrangement equally hopeless."

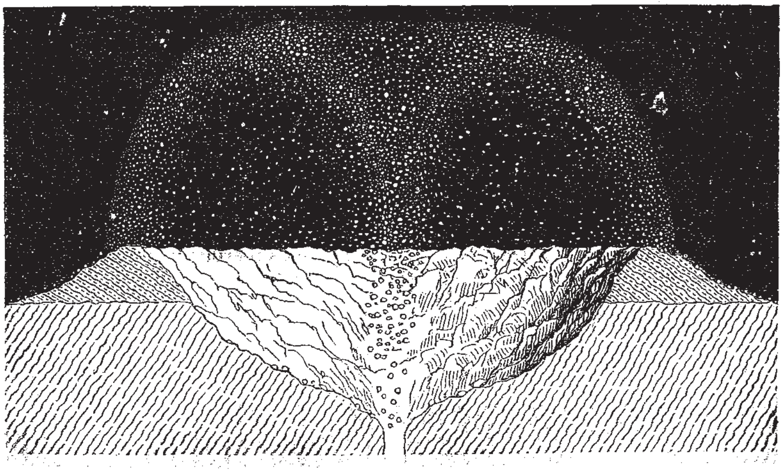

FIG. 2.—Second stage. The crater increases its diameter

Quite different from these radiating streaks are very definite "cracks," some of which are easily seen with moderate telescopic powers. There are, however, a very large number recorded, some of which are excessively delicate objects.

Last among exceptional phenomena to be recorded is the circumstance that our satellite has no atmosphere to speak of: no clouds, no fogs have ever been seen on the moon as on Mars, while no effects have been produced at occultations of stars and planets by the moon such as should be produced did an atmosphere in any way comparable to our own exist on our satellite.

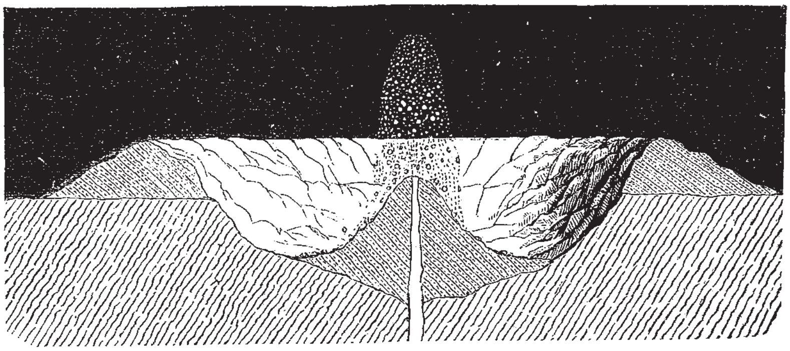

FIG. 3.—Third stage. The central cone is formed by a reduced action

Although the most important part of the text consists of an attempted explanation of all but the atmospheric phenomena, much of it deals, and in a very admirable way, with lunar topography, a perusal of which will be desirable before the discussion is taken up, in the case, at all events, of those unfamiliar with the moon's surface. The consideration of the various questions involved is preceded by chapters on the cosmical origin of our system and the generation of heat, the result of which was that at one time the moon was an incandescent sphere with a cooling crust, and even then if I understand the authors, there was no lunar atmosphere (p. 17), for they give an answer, or think they do, in this sense to the question

"How can a volcanic theory of the lunar phenomena be upheld consistently with the condition that it possesses no atmosphere to support Fire?"

In the chapter on the cooling of the crust (Chap. III.), special attention is directed to observations tending to show that cast-iron and even slag and Vesuvian lava expand on cooling. This will be new to physicists:—

"The broad general principle of the phenomenon here referred to is this: That fusible substances are (with few exceptions) specifically heavier while in their molten condition than in the solidified state, or in other words, that molten matter occupies less space, weight for weight, than the same matter after it has passed from the melted to the solid condition. It follows as an obvious corollary that such substances contract in bulk in fusing or melting, and expand in becoming solid. It is this expansion upon solidification that now concerns us.

"Water, as is well known, increases in density as it cools, till it reaches the temperature of 39° F., after which, upon a further decrease of temperature, its density begins to decrease, or in other words, its bulk expands, and hence the well-known fact of ice floating in water, and the inconvenient fact of water-pipes bursting in a frost. This action in water is of the utmost importance in the grand economy of nature, and it has been accepted as a marvellous exception to the general law of substances increasing in density (or shrinking) as they decrease in temperature. Water is, however, by no means the exceptional substance that it has been so generally considered. It is a fact perfectly familiar to iron-founders, that when a mass of solid cast-iron is dropped into a pot of molten iron of identical quality, the solid is found to float persistently upon the molten metals—so persistently that when it is intentionally thrust to the bottom of the pot, it rises again the moment the submerging agency is withdrawn" (p. 20).

There will be many for whom this part of the work will possess great interest, but I take it few will accept the startling conclusions drawn from the asserted expansion.

"This expansion of volume which accompanies the solidification of molten matter furnishes a key to the solution of the enigma of volcanic action; and that such theories as depend upon the agency of gases, vapours, or water are at all events untenable with regard to the moon, where no gases, vapour, or water appear to exist" (p. 27).

I will return to this point presently, but meantime let us follow the contracting globe. Messrs. Nasmyth and Carpenter quite accept tangential pressure as being the only true cause of elevation, and its effect is very well put:

"When the molten sub-stratum had burst its confines, ejected its superfluous matter, and produced the resulting volcanic features, it would, after final solidification, resume the normal process of contraction upon cooling, and so retreat or shrink away from the external shell. Let us now consider what would be the result of this. Evidently the external shell or crust would become relatively too large to remain at all points in close contact with the subjacent matter. The consequence of too large a solid shell having to accommodate itself to a shrunken body underneath, is that the skin, so to term the outer stratum of solid matter, becomes shrivelled up into alternate ridges and depressions or wrinkles" (p. 28).

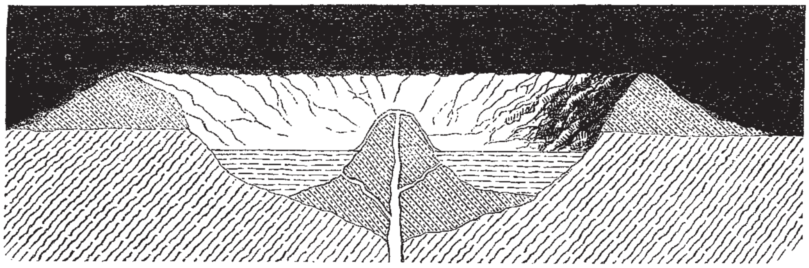

FIG. 4.—Fourth stage. The old crater is nearly filled with lava, leaving the cone visible in the centre

The preceding extracts will give an idea of the authors' view of the general phenomena which accompanied the cooling of the crust. We have no atmosphere, the crust as it cools expands and cracks, and through these cracks the interior liquid is ejected, and finally tangential pressure does the rest.

Now leaving the question of the atmosphere for a time, let us compare this with Mr. Mallet's reasoning. As a planet cools, the crust thickens, and the nucleus contracts; the crust must follow the nucleus, hence tangential pressure and its concomitants, elevation where possible, where not possible then tremendous interior motions, which motions are converted into heat, which heat + water produces volcanic activity. Further, the smaller a globe is, the more rapidly will it cool, and the more marked will the phenomena which accompany cooling be. Hence Mr. Mallet's hypothesis is competent to explain all the extreme development of volcanic activity on the moon by exactly similar causes which we know to have gone on here.

Now as I have said, Mr. Mallet wants water for his volcanoes, both here and on the moon, but Messrs. Nasmyth and Carpenter will not even allow that an atmosphere, still less water, has ever existed there. Now here I unhesitatingly range myself on the side of Mr. Mallet. I believe in an absolute uniformity throughout all Nature in such matters. I do not mean uniformity of matter, so far as chemical materials go, but of manner.

Now what is an atmosphere? or to put the question more specifically, what is our atmosphere? Is it not a residue? We have free oxygen in the atmosphere at the present time; had we not very much more before the various metals which now exist in combination with that metalloid existed in their pure state? Now how has combination been brought about? By exposing the metals to the atmosphere and its contained oxygen. Now suppose the machinery, the function of which in past time has been to bring these metals to the surface, had been a thousand times more powerful, would there be as much oxygen in the air now as there is? A child can answer this question, and it is one of several which might be asked all tending to show that it is as unnecessary as it is unphilosophical to suppose that there never was a lunar atmosphere, because there is only a tenuous one at the best now. I shall not follow this subject out further now because it is part of a larger one, which deals with the atmospheres and densities of all the bodies of our system, and to discuss it at length would lead me too far from the present subject; suffice it to say that the enormous atmospheres of Saturn and Jupiter and the absence of a lunar atmosphere result from one single cause, that cause being if I mistake not the chemical constitution of the exterior parts of the solar nebula as each planet was thrown off, and the subsequent action on each globe.

To come to details. Whether the walled plains are really due to volcanic action or not, our authors offer no opinion beyond referring to the hypothesis of Prof. Dana, as being the most rational. Dana suggested that, as at Kilauea, the lava was simply boiling, and gradually extending its boundaries from a centre, so that at last, if the heat continued, a quasi-crater might be formed of any extent. That the smaller craters are true craters Messrs. Nasmyth and Carpenter take great pains to show, and their evidence is of the closest and most satisfactory kind. The woodcuts which we produce will show how the central cones, which *are scarcely ever absent in the craters we are now discussing*, have originated on the theory advanced; at the same time it is shown how, on this idea, even when the central cone is absent or the crater is filled to the brim, as in the case of Wargentin, one of the most curious of lunar objects, the effects observed may be explained.

Mr. Nasmyth long ago illustrated the bright streaks on the moon by the experiment which he here details, and a very striking one it is. He took a glass globe, filled it with water, and having hermetically sealed it, plunged it into warm water, "the enclosed water expanding at a greater rate than the glass, exerts a disruptive force on the interior surface of the latter, the consequence being that at the point of least resistance the globe is rent by a large number of cracks diverging in every direction from the focus of disruption."

From the photograph, it is clear that the result is strikingly similar to the rays which have Tycho for a focus, and on the strength of this similarity the authors claim this as another effect of expansion due to cooling. If so, however, the experiment with the glass globe is not in point. But however the cracks were produced, they imagine that thus having them travelling along for hundreds of miles irrespective of surface inequality, there was an up-flow of molten matter which spread out on both sides and turned the narrow crack into a broad streak.

I trust I have said enough about this book to induce all interested in physical problems to peruse it for themselves; it is altogether an admirable production, and if space permitted each picture even would merit a special paragraph.

J. NORMAN LOCKYER

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Natural Selection and Dysteleology

IN his reply to a criticism which appeared in NATURE, Prof. Struthers alluded to a question of considerable interest to evolutionists, viz., whether or not the presence of useless organs "proves too much for the argument." [*] The difficulty is one often met with, and has been well stated by Prof. Huxley, thus:—"Prof. Haeckel has invented a new and convenient name, 'Dysteleology,' for the study of the 'purposelessnesses' which are observable in living organisms—such as the multitudinous cases of rudimentary and apparently useless structures. I confess, however, that it has often appeared to me that the facts of dysteleology cut two ways. If we assume, as evolutionists in general do, that useless organs atrophy, such cases as the existence of lateral rudiments of toes, in the foot of a horse, place us in a dilemma. For, either these rudiments are of no use to the animal—in which case, considering that the horse has existed in its present form since the pliocene epoch, they surely ought to have disappeared—or they are of some use to the animal, in which case they are of no use as arguments against teleology," &c.[†]

Now it appears to me (as I think it must to all upon adequate consideration), that the dilemma thus presented is only apparent; its first-mentioned horn having no existence. In other words, we can never in any single case be sure that any length of time would have been sufficient to enable natural selection totally to obliterate a useless organ.

Mr. Darwin, in the "Origin" and in the "Variation," has mentioned three causes which operate towards the removal of useless structures. These causes are Selection, Disuse, and Economy of Growth. Recently he has suggested a fourth cause, which may be epitomised as the dwarfing influence of impoverished conditions, progressively reducing the average size of the useless structure, by means of free intercrossing.[‡] I shall endeavour to show that these causes are not sufficient to obtain the complete extinction of rudimentary parts in all cases.

Selection may be considered as applying only to those rare instances in which changed conditions of life may be supposed to have rendered a previously useful organ injurious; for so far as selection operates in obliterating a merely useless organ, it will be more convenient, for the sake of brevity, to identify it with the Economy of Growth.[§] Since, however, it is obvious that an injurious organ must pass through the merely useless stage before it becomes wholly suppressed, we may dismiss this cause without further comment.

Disuse and Economy of Growth are so much entangled in their operation, that it is hopeless to find examples illustrating their separate action. In so far, therefore, as we choose to disentangle them, we must discuss the question in the abstract.

Disuse may be left out of the question, so far as its influence is due to the principle of inheritance at corresponding periods of life; for, as Mr. Darwin tersely observes, "as most organs could be of no use at an early embryonic period, they would not be affected by disuse; consequently they would be preserved at this stage of growth, and would remain as rudiments." [||] It may,

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[*] NATURE, vol. ix p. 83.

[†] "Critiques and Addresses," pp. 307–8.

[‡] NATURE, vol. viii. pp. 432 and 505.

[§] I think, also, that if the Economy of Growth is really a principle independent of the "more general principle," viz., the *direct* influence of "natural selection in continually trying to economise every part of the organisation" (Compare "Origin," 1873, pp. 117–18), it may yet, without any great stretch of inference, be considered as due to the *indirect* influence of natural selection. For, the survival of the fittest demands that each individual shall utilise its stock of nutriment to the best advantage; and, this demand being continued through many generations, it does not seem in itself improbable, that it should thus at last secure to all the members of the surviving species an inherited tendency so to economise their nutritive power when fresh occasion requires—an advantageous innate *temperament* distinct from the external *eliminative* agency of Natural Selection. Only in some such way can we account for the facts of acclimatisation, in those cases where the adaptive changes take place immediately after the transportation of the organism: also for an analogous class of facts, such as that of the shells in the same species of Mollusca, differing in their thickness upon the weather and the lee sides of the Plymouth breakwater.

[||] "Variation," vol. ii. p. 317. I may mention, also in passing, that it seems to me not unopen to question whether disuse is the *principal* cause even of reduction. There is no doubt that disuse causes more or less of atrophy in the individual, and from this fact it is argued, that the principle of inheritance at corresponding periods of life must entail the continued reduction of a disused part in the species. Now the only effect of the principle relied on is that of prolonging, as it were, the life of the disused part over many generations—thus affording it an indefinite time to succumb to the conditions which reduced it in the life of the individual. But it is necessary for the validity of the inference that it would so succumb, to show that these conditions are the efficient causes of this reducing process in the one case, as they prove themselves to be in the other. Suppose, for instance, that failure of nutrition is the principal cause of atrophy under disuse, does it follow when such failure has done, to all appearance, its utmost during the life of the individual (as we see in disease), that it could do any more were that life indefinitely prolonged? Of course in the case of short-lived animals, where the dwarfing influences may not have time to exhaust themselves in a single generation, the principle of inheritance at corresponding ages may be drawn